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Pathogens Associated with Foliar Blight of Onion

Efath Shahnaz[1*], V.K. Razdan[2] and Saba Banday[1]

[1]Division of Plant Pathology, Sher-e-Kashmir University of Agricultural Sciences & Technology-Kashmir, Shalimar Campus, 190025
[2]Division of Plant Pathology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, 180009, India

Corresponding author

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A B S T R A C T

Onion is an important crop grown worldwide for its culinary and medicinal properties. One of the major bottlenecks in its production is the foliar blight disease. The disease is responsible for causing huge losses in its successful production. Pathogens isolated from the onion foliar blight symptomatic leaves for two successive cropping seasons were *Alternaria alternata, A. porri, A. tenuissima, Stemphylium vesicarium, Cladosporium allii-cepae* and *Colletotrichum circinans*. However, the relative occurrence of the pathogens varied during the cropping season.

Introduction

Among the various diseases of onion that are responsible for causing the widespread destruction of the crop, foliar blight is perhaps the most important and yet, least understood disease. The disease has been attributed to a number of pathogens but very few workers have realized that the disease is in fact caused by a number of pathogens in association. The pathogens considered in order of importance, include *Perenospora destructor* (Berk) Casp (downy mildew), *Alternaria porri* (Ellis) Cif.(purple blotch), *Sclerotinia squamosa* (Vienn. Bourg.) Dennis (leaf rot or blast), *Botrytis cinerea* Rud. (leaf spot, collar rot), *Cladosporium allii-cepae* (Ranojevic) M. B. Ellis (leaf blotch), *Puccinia allii* (DC) Rud. (rust), *Pleospora herbarium* (Pers.ex Fr.) Rabert. (black stalk rot), *Stemphylium vesicarium* (Wallr.) Simmons (leaf blight), *Glomerella cingulata* (Stonem) Spauld. and Schrenk (seven curls disease) and *Cercospora duddiae Welles* (leaf spot) (Maude, 1990). The foliage fungal diseases of onion as reported by Mukerji and Bhasin (1986) include *Alternaria porri, A. alternata, A. cepulicola, A. palandui, A. pallii, Colletotrichum lindemuthianum, Heterosporium allii cepae, Levuilla taurica, Macrophimina cladosporoides, Phyllosticta allii, Pithomyces maydicus, Puccinia porri*

and *Stemphylium botroysum.*Suheri and Price (2000) reported that both *A. porri* and *S. vesicarium* were potentially important pathogens of winter grown *Allium* crops and purple leaf blotch symptoms were considered to be a complex caused by both the pathogens. *Stemphylium botryosum* (*Pleospora herbarum*), *S. vesicarium* and *Alternaria alternata* were isolatedin 93.7, 12.5 and 50.0 per cent of the samples, respectively (Cova and Rodriguez, 2003).

Rarely only one pathogen is associated with the disease. Keeping in view this fact an experiment was undertaken at the University Research Farm, Faculty of Agriculture of the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu to ascertain the true nature and etiology of the disease so that the appropriate management practices may be based on such information.

Materials and Methods

Disease samples with typical blight symptoms were collected in perforated polyethylene bags at regular intervals. Ten locations in seven villages of Jammu district belonging to three Tehsils, *viz.*, Akhnoor, Bishnah and R. S. Pura; ten locations in two villages of Tehsil Reasi of district Udhampur; two locations in village Thandapani of Tehsil Sunderbani of district Rajouri; and eight locations in five villages of Tehsil Hiranagar of district Kathua, known for onion cultivation, were selected for recording the observations. Disease intensity was recorded at fifteen day intervals starting from the first week of February. During the survey all types of blight symptoms, including Alternaria blight, were considered and evaluated for their intensity.

The following scale was used for rating disease intensity (Sharma, 1986):

0 : No disease symptoms

1 : Few spots towards the tip, covering less than 10 per cent leaf area

2 : Several dark purplish patches, covering less than 20 per cent leaf area

3 : Several patches with paler outer zone, covering up to 40 per cent leaf area

4 : Long streaks, covering 75 per cent leaf area or breaking of leaves from centre

5 : Complete drying of leaves or breaking of leaves from base.

The per cent disease intensity (PDI) was calculated as given below (Wheeler, 1969):

$$PDI = \frac{\text{Total sum of numerical ratings}}{\text{Number of leaves observed} \times \text{Maximum disease rating}} \times 100$$

Samples were collected from these locations after every fifteen days and brought to laboratory for disease assessment.

Disease lesions of 5-10 mm^2, along with the healthy-looking tissue were cut from the leaves and stalks showing blight symptoms. The sterilized pieces were dried on sterile blotter paper, transferred aseptically to potato dextrose agar (PDA) poured petriplates and incubated at 25±2^oC for 14 days, in an inverted position. The incubated plates were observed for the growth of fungal colonies from the second day onwards. Purification of the cultures was done by hyphal tip method and the cultures were maintained on PDA slants for further studies. The identification of the purified cultures was done with the help of standard texts and manuals (Simmons, 1967; Simmons, 1969; Subramanian, 1971 and Chowdhry *et al.*, 2000). Frequency of the

pathogens associated with the foliar blight of onion was calculated by assessing the recovery of each pathogen from the total number of isolations made.

Thirty five day old onion plants grown in 12" pots under glass house conditions were inoculated separately with the blight pathogens, isolated from the naturally infected disease samples. At the site of inoculation three pricks were given on the leaf tissue by a sterilized stainless steel needle and then 5 mm mycelial disc of ten day old pathogen culture was placed on it. Leaves kept as check were only pin pricked without placing mycelial disc on them. Observations on the symptom development were recorded after 24 hours of inoculation.

Results and Discussion

In Jammu district, the average disease intensity increased from 6.37±0.97 per cent in the 7th standard week (SW) to 20.91±4.80 per cent in the 13th SW in the year 2005, whereas, in the year 2006, the corresponding values were 3.57±0.18 and 11.57±0.64 per cent, respectively. The average disease intensity in the Udhampur district ranged from 4.56±0.36 per cent in the 7th SW to 13.03±1.62 per cent in the 13th SW in 2005, and in the year 2006, from 5.39±0.14 per cent to 13.35±0.29 per cent, respectively.

In the year 2005, in Rajouri district, the average disease intensity ranged from 13.31±0.14 per cent in the 7th SW to 37.26±0.33 per cent in the 13th SW, whereas, in the year 2006, disease intensity of 2.32±0.35 per cent was recorded in the 7th SW which increased to 15.98±6.68 per cent in the 13th SW. In Kathua district, the average disease intensity increased from 7.16±0.51 per cent in the 7th SW to 25.43±2.33 per cent in the 13th SW, in the year 2005, whereas, in the year 2006, the average disease intensity recorded was 4.35±0.10 per cent and 16.99±3.03 per cent, respectively.

Frequency of different foliar blight pathogens

Pathogens isolated from the onion foliar blight symptoms during two successive cropping seasons were *Alternaria alternata, A. porri, A. tenuissima, Stemphylium vesicarium*, *Cladosporium allii-cepae* and *Colletotrichum circinans* (Plate I and II). The relative occurrence of the pathogens varied during the cropping season (Table). *A. alternata* was isolated from 37.00 (January) to 55.25 (April) per cent of the diseased samples observed throughout the growing season.

The presence of *A. porri* was detected at the end of February (7.00 per cent) and was found to increase (31.25 per cent) with the crop growth during the month of March and reached its maximum frequency (75.60 per cent) towards the end of cropping season in April. The per cent incidence of *A. tenuissima* ranged from 1-10 per cent throughout the crop period. *Stemphylium vesicarium* was also invariably found associated with typical blighted onion leaves throughout the growing period (82.75 per cent in January to 77.40 per cent in February), though its relative occurrence declined slightly in March (49.15 per cent) and April (37.75 per cent). *Cladosporium allii-cepae* was isolated in only 1 per cent of the diseased leaves in February and 3.75 per cent in March, whereas, *Colletotrichum circinans* was isolated from February (2.25 per cent) to April (4.25 per cent).

Symptomatology

It was observed that the infection by each of the six foliar blight pathogens *viz., Alternaria alternata, A. porri, A. tenuissima, Stemphylium vesicarium, Colletotrichum allii-cepa* and *Cladosporium allii-cepae* resulted in distinct symptom expressions on the host (onion).

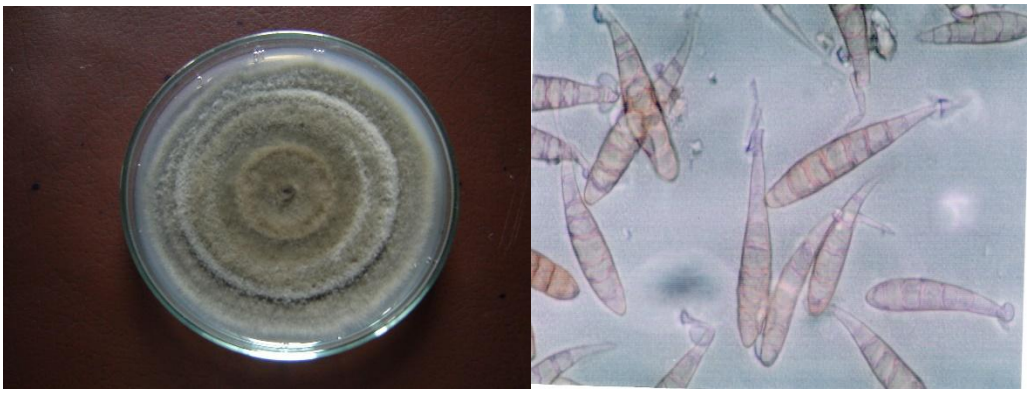
Table.1 Per cent disease intensity of onion foliar blight at various locations in Jammu division during the first year

District/Tehsil	Location	Standard week			
		7	**9**	**11**	13
Jammu					
Akhnoor	Sidharuan	06.53	09.71	10.10	**11.91**
	Garkhal	05.63	08.15	17.55	**23.68**
Bishnah	Kotli I	09.71	10.29	18.95	**30.16**
	Kotli II	03.30	05.63	10.92	**23.57**
	Kotli III	02.93	08.66	08.89	**25.49**
	Ismailpur	05.02	06.63	12.87	**22.41**
	Prithvipur	02.19	03.43	04.65	**09.32**
R. S. Pura	Tale	08.55	12.48	18.45	**22.32**
	Chakroi I	11.48	17.16	18.89	**21.69**
	Chakroi II	08.44	16.23	19.88	**22.53**
	Mean ± S.E.(m)	**6.37±0.97**	**9.83±1.91**	**14.12±2.83**	20.91±4.80
Udhampur					
Reasi	Aghar Balliyan I	03.30	04.95	06.82	**08.10**
	Aghar Balliyan II	01.19	03.50	05.42	**06.18**
	Aghar Balliyan III	02.63	04.82	07.84	**10.00**
	Aghar Balliyan IV	05.19	06.75	10.00	**13.00**
	Aghar BalliyanV	04.32	06.16	12.14	**13.25**
	Aghar Balliyan VI	05.51	07.26	10.81	**13.96**
	Aghar Balliyan VII	04.10	05.34	13.12	**15.00**
	Gran Morh I	05.21	06.54	11.66	**14.10**
	Gran Morh II	06.25	10.40	15.32	**17.17**
	Gran Morh III	07.86	09.94	14.91	**19.56**
	Mean ± S.E. (m)	**4.56±0.36**	**6.57±0.48**	**10.80±1.10**	13.03±1.62
Rajouri					
Sunderbani	Thandapani I	13.68	22.39	27.25	**35.97**
	Thandapani II	12.93	22.53	29.11	**38.55**
	Mean ± S.E. (m)	**13.31±0.14**	**22.46±0.05**	**28.18±0.17**	37.26±0.33
Kathua					
Hiranagar	Gadyal I	09.96	11.32	15.63	**19.18**
	Gadyal II	06.29	13.14	23.74	**31.68**
	Gadyal III	07.25	13.40	22.34	**27.66**
	Gadyal IV	06.35	07.93	16.00	**22.69**
	Khangal	04.51	11.82	21.07	**23.38**
	Daichak	09.61	18.80	21.67	**28.39**
	Nathal Chak	08.57	13.68	18.34	**28.87**
	Pargwal	05.06	09.07	18.47	**21.58**
	Mean ± S.E. (m)	7.16±0.51	12.39±1.37	19.66±1.12	25.43±2.33

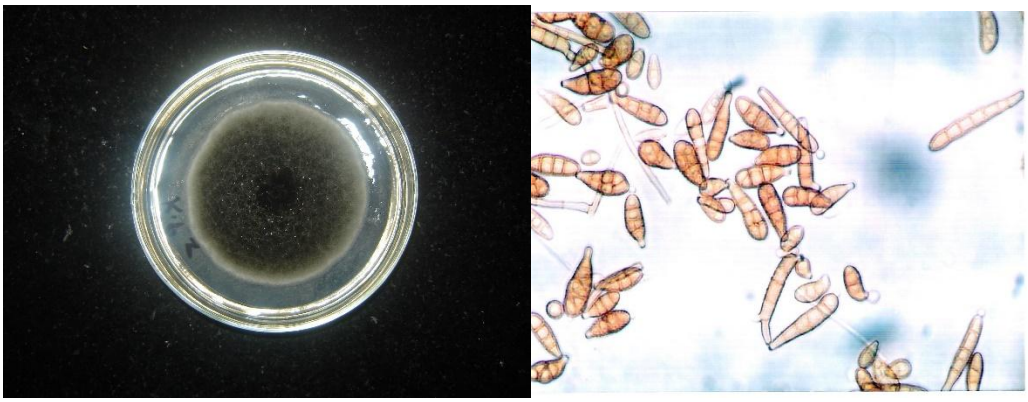
Table.2 Per cent disease intensity of onion foliar blight at various locations in Jammu division during the second year

District/Tehsil	Location	Standard week			
		7	**9**	**11**	13
Jammu					
Akhnoor	Sidharuan	02.12	04.00	06.93	**08.79**
	Garkhal	03.42	05.02	06.63	**08.36**
Bishnah	Kotli I	04.93	08.95	12.48	**15.00**
	Kotli II	04.72	08.79	10.45	**13.68**
	Kotli III	05.83	09.32	10.10	**12.41**
R. S. Pura	Ismailpur	01.77	03.42	05.86	**07.63**
	Prithvipur	02.91	04.31	07.77	**10.93**
	Tale	03.41	06.63	09.71	**12.31**
	Chakroi I	04.33	07.55	08.15	**13.05**
	Chakroi II	02.22	04.65	08.86	**13.58**
	Mean ± S.E.(m)	**3.57±0.18**	**6.26±0.51**	**8.69±0.41**	11.57±0.64
Udhampur					
Reasi	Aghar Balliyan I	04.22	07.36	09.09	**11.97**
	Aghar Balliyan II	05.42	11.32	12.93	**14.10**
	Aghar Balliyan III	04.33	09.03	11.58	**13.00**
	Aghar Balliyan IV	06.63	10.52	11.82	**13.40**
	Aghar BalliyanV	05.97	09.82	12.30	**15.00**
	Aghar Balliyan VI	03.16	06.69	08.48	**09.53**
	Aghar Balliyan VII	06.78	11.97	13.26	**15.02**
	Gran Morh I	05.29	10.00	11.32	**14.93**
	Gran Morh II	05.45	10.45	12.93	**14.08**
	Gran Morh III	06.63	08.15	10.92	**12.48**
	Mean ± S.E. (m)	**5.39±0.14**	**9.53±0.29**	**11.46±0.26**	13.35±0.29
Rajouri					
Sunderbani	Thandapani I	01.72	03.43	05.02	**18.56**
	Thandapani II	02.91	04.61	06.83	**13.39**
	Mean ± S.E. (m)	**2.32±0.35**	**4.02±0.35**	**5.93±0.82**	15.98±6.68
Kathua					
Hiranagar	Gadyal I	02.93	05.63	08.15	**10.08**
	Gadyal II	04.72	07.39	12.61	**15.62**
	Gadyal III	05.45	14.88	17.16	**23.57**
	Gadyal IV	03.98	05.02	12.48	**20.69**
	Khangal	05.52	10.92	15.62	**18.89**
	Daichak	04.65	06.38	13.68	**14.88**
	Nathal Chak	03.43	06.52	07.74	**10.92**
	Pargwal	04.10	05.02	12.87	**21.30**
	Mean ± S.E. (m)	4.35±0.10	7.72±1.49	12.54±1.33	16.99±3.03

PLATE I



(a) **(d)**



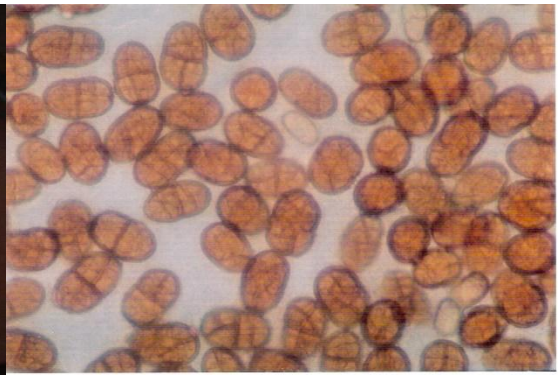
(b) **(e)**

(c) **(f)**

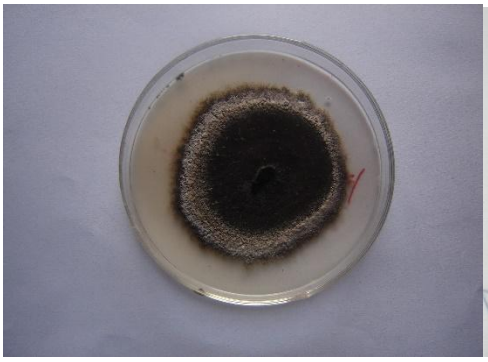
Cultural characteristics of (a) *Alternaria porri*, (b) *Alternaria tenuissima* and (c) *Alternaria alternata*; Conidia of (d)*Alternaria porri*, (e) *Alternaria tenuissima* and (f) *Alternaria alternata*

PLATE II

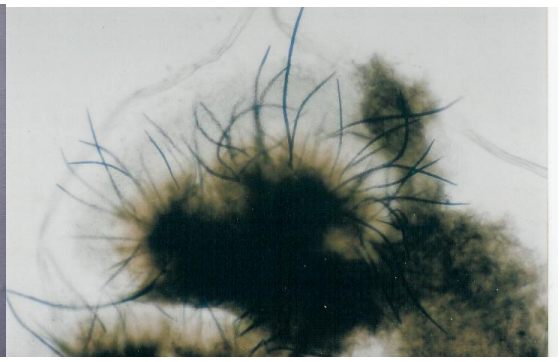
(g)



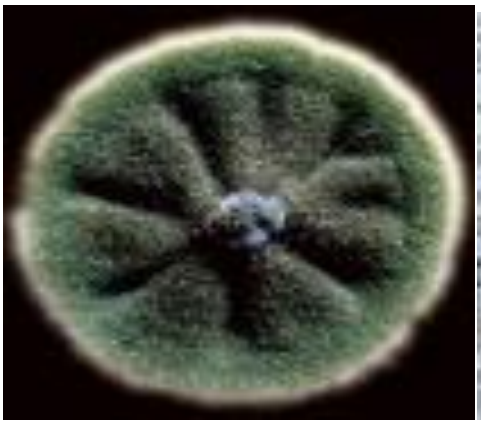
(j)



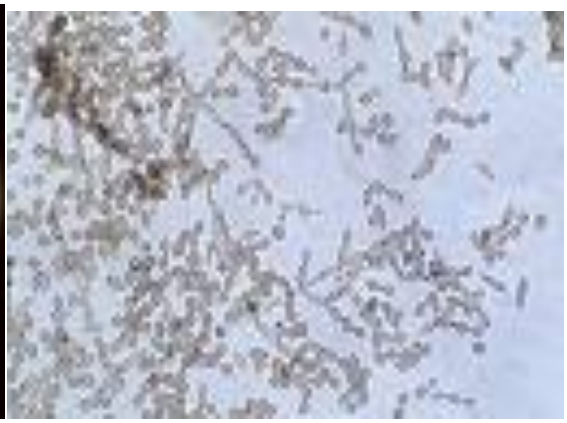
(h)



(k)



(i)



(l)

Cultural characteristics of (g) *Stemphylium vesicarium*, (h) *Colletotrichum allii-cepa* and (i) *Cladosporium allii-cepae*; Conidia of (j) *Stemphylium vesicarium*, (k) *Colletotrichum allii-cepa* and (l) *Cladosporium allii-cepae*

Table.3 Frequency of different foliar blight pathogens associated with the onion crop for two successive cropping seasons

Pathogen	January			February			March			April		
	1st year	2nd Year	Average	1st year	2nd Year	Average	1st year	2nd Year	Average	1st year	2nd Year	Average
Alternaria alternata	39.00	35.00	37.00	42.50	38.00	40.25	51.50	45.00	48.25	60.00	50.50	55.25
Alternaria porri	00.00	00.00	00.00	09.00	05.00	07.00	33.50	29.00	31.25	80.70	70.50	75.60
Alternaria tenuissima	02.50	00.50	01.50	04.80	02.00	03.40	07.00	05.50	06.25	11.30	08.30	09.80
Stemphylium vesicarium	85.50	80.00	82.75	79.30	75.50	77.40	55.00	43.30	49.15	40.50	35.00	37.75
Cladosporium allii-cepae	00.00	00.00	00.00	02.00	00.00	01.00	05.00	02.50	03.75	00.00	00.00	00.00
Colletotrichum circinans	00.00	00.00	00.00	02.50	02.00	02.25	04.30	03.50	03.90	04.50	04.00	04.25

Mean of 500 readings

On the leaves inoculated with *A. porri*, small, sunken, whitish flecks with purple coloured centres developed which later on coalesced to form large dead patches covering several square centimeters of the leaf. The purplish area of the spot was separated from the healthy green tissues by a narrow, light coloured zone. Within a period of 15-21 days, alternating light and dark zones became clearly differentiated over the whole purple surface of the leaf. Both *A. alternata* and *A. tenuissima* also formed similar purple patches as in case of *A. porri*. The patches enlarged and resulted in blight and wither-tip. The inoculations made with *S. vesicarium* manifested into small, white, spindle-like lesions which turned to light yellow in colour and later changed to brown or purple. Within few days, the entire leaf had a blighted appearance. The spots caused by the inoculations with *C. allii-cepae* were pale brown in colour, which enlarged into lens shaped lesions. The leaves appeared blighted under warm and moist conditions. The inoculations with *C. circinans* resulted in the development of small, black coloured lesions which were surrounded by a pale outer zone. Slightly raised acervuli of the fungus became clearly visible on the inoculated leaves at the later stage.

Under the field conditions it was observed that the conidia belonging to *Alternaria porri* and *Stemphylium vesicarium* were associated with the purple and black lesions (Plate III, c and d), whereas, *A. alternata, A. tenuissima* and *S. vesicarium* were isolated mostly from blighted portions. *Cladosporium allii-cepae* was commonly isolated from the blighted leaves showing velvety growth of fungus. *Colletotrichum circinans* was isolated from relatively few lesions during the growth period of the onion crop. However, the acervuli of *C. circinans* were clearly distinguishable on the dried seed stalk debris owing to the formation of black raised lesions (Plate III, f).

Pathogens found associated with the foliar blight were *Alternaria alternata, A. porri, A. tenuissima, Stemphylium vesicarium, Cladosporium allii-cepae* and *Colletotrichum circinans.* However, the relative occurrence of the pathogens varied during the cropping season. *A. alternata* was isolated from 37.00-55.25 per cent of the diseased leaf samples observed throughout the growing season. Cova and Rodriguez (2001) have also found *A. alternata* to be responsible for the foliar blight of onion. Linares and Gracia (1985) reported that plants kept in an inoculation chamber and inoculated with *A. alternata* developed symptoms very similar to those of *A. porri.* The presence of *A. porri* was

detected at the end of February (7.00 per cent) and was found to increase with the crop growth and reached its maximum frequency (75.60 per cent) towards the end of the cropping season in April. Similar results were reported by Ariosa and Herrara (1984) who noted that the first symptoms of the disease appeared 50 days after sowing and disease intensity was highest at 110 days after sowing. Chawda and Rajasab (1994) also reported that purple blotch symptoms appeared in the field five days after the first rain after transplantation. Warm weather with occasional rains has been described as ideal conditions for epiphytotic development of the disease caused by *A. porri* (Nolla, 1927). Similar weather conditions prevailed from the second fortnight of February onwards in both the successive cropping seasons resulting in conducive environment for the disease development. Onion leaves have been reported to become more susceptible to *A. porri* as they age and bulbs approach maturity (Miller, 1983). Lakra (1999) also reported that purple blotch/spot started appearing in mid-February and became supernumery by end of March.

A. tenuissima was isolated from 1-10 per cent of the blighted leaves throughout the growing period. It has been found that *A. tenuissima* could cause considerable damage, especially by top killing of the foliage (Skiles, 1953). Our observation of more than one species being responsible for onion foliar blight is in conformity to the findings of Skiles (1953) who had proposed the name "Alternaria blotch" to describe the disease complex of onion caused by three species of *Alternaria, viz., A. porri, A. tenuis* and *A. tenuissima.*

Stemphylium vesicarium was invariably found associated with typically blighted onion leaves throughout the growing period (82.75 per cent in January to 77.40 per cent in February), though its relative occurrence declined slightly in March (49.15 per cent) and April (37.75 per cent). The results of the present study are in conformity with Jakhar *et al*. (1996) who reported that the disease caused by *Stemphylium* first increased gradually, and then decreased late in the season. The results of the present study revealed that the symptoms of *A. porri* and *S. vesicarium* were indistinguishable in the field, which is in conformity with the results of Suheri and Price (2000) who reported that typical purple blotch lesions in the field were often colonized by both the pathogens. Aveling *et al*., (1993) showed that *S. vesicarium*, in conjunction with *A. porri*, was a destructive foliar and seed stalk pathogen of onion under warm, moist conditions.

Cladosporium allii-cepae was isolated in only 1 per cent of the diseased leaves in February and 3.75 per cent in March, whereas, *Colletotrichum circinans* was isolated from February (2.25 per cent) to April (4.25 per cent). Ryan *et al.* (1981) also reported severe blighting of onion crop due to *C. allii-cepae*, which usually coincided with the onset of senescence in the foliage. Hall and Kavanagh (1985) reported that *C. allii-cepae* forms an olive green velvety growth of sporulating mycelium on the surface of lesions and under conditions conducive to disease development the crop appeared blighted. Young, bleached lesions, typical of *A. porri* infection in dry conditions, might be confused with those of *C. allii-cepae* (Ryan, 1978). Gupta *et al.* (1994) have identified Stemphylium blight (*S. vesicarium*) and purple blotch (*A. porri*) as diseases of national importance, whereas, Colletotrichum blight was found to be localized in Maharashtra.

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